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MINERALOGY OF SHALE SAMPLES FROM BETWEEN COAL SEAMS IN THE HIGHVALE MINE, SUNDANCE, ALBERTA

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MINERALOGY OF SHALE SAMPLES FROM BETWEEN COAL SEAMS IN THE HIGHVALE MINE, SUNDANCE, ALBERTA

by

J.A. Soles

SUMMARY

Bloated lightweight aggregate made from inter-coal seam shale from the Highvale coal mine near Sundance, Alberta yielded concrete of relatively low compressive strength. Petrographic and mineralogical analyses of samples os the shale and one bloated specimen revealed that the shale is principally iron-poor kaolinite and montmorillonoid that bloats irregularly to poorly at the temperatures used. Utilization of the shale as expanded lightweight aggregate may depend on determining the most favourable bloating temperature range.

RÉSUMÉ

On a obtenu à partir d'un agrégat léger dilaté fait à partir de schiste provenant d'entre deux couches de charbons de la mine de charbon de Highvale prés de Sundance, en Alberta, du béton dont la résistance à l'écrasement est relativement faible. Les analyses pétrographiques et minéralogiques d'échantillons de schiste et d'un spécimen dilaté.

Ont montré que le schiste est principalement constitué de kaolinite pauvre en fer et de montmorillonite qui gonfle irréguliérement à pauvrement selon la température utiliseé. L'utilisation que l'ont peut faire du schiste comme agrégat léger dilaté dépend de l'échelle de température lors de la dilatation la plus favorable.

INTRODUCTION

The bloating characteristics of shaly rock at two different levels in the Highvale coal mine near Sundance, Alberta, have been tested to determine the usefulness of this waste material as a source of lightweight aggregate (1). The tests produced a mottled white to dark grey, finely vesicular product having a relatively low compressive strength, which was considered generally unsatisfactory for aggregate use. To determine the probable cause of poor bloating, mineralogical analyses were made of the samples and one bloated specimen.

MATERIALS, PROCEDURES

The two samples of shale provided were located between two different sets of coal seams:

Sample 3707-82: Shale between coal seams 3 and 4;

Sample 3708-82: Shale between seams 2 and 3.

The bloated specimen was a crushed sample of the latter material.

X-ray diffraction analyses were made on bulk samples of the two rocks crushed for the bloating tests. In addition, untreated specimens of rock from the two sites were examined under the stereomicroscope and samples free from coal and carbonaceous debris were also selected for analysis. One petrographic thin section and a ground, impregnated section were made from the bloated specimen to examine the structure and phases resulting from thermal treatment.

RESULTS

Both rocks are light to dark brown, aphanitic shales containing seams, films and scattered particles of coal; silt-size particles are rare. When dry, the shale is indistinctly stratiform and breaks with a conchoidal fracture (Fig. 1), but immersion in water causes rapid swelling,

fragmentation and lamellar disintegration (Fig. 2). Sample 3708-82 is darker; it contains more coal and perhaps more dark clay minerals.

A surficial study of a bloated specimen of Sample 3708-82 revealed that the particles of crushed shale had expanded considerably, yielding fine- to medium-sized, closed intragranular vesicles in a mottled, white to dark grey, glassy matrix. Intergranular pores are irregular and large. Many individual particles and groups of particles change from white on the outside to dark grey on the interior, where the intragranular porosity is generally lower. Some of the dark, poorly bloated fragments have developed pale lamellar partings. The various features are shown in Fig. 3.

The bloated white particles have been sintered to the point of fusion at mutual grain boundaries, and their cohesive strength is noticeably greater than the darker particles, which frequently show boundary lines. A ground surface section (Fig. 3) illustrates the bloated structure of the specimen. The matrix is vitric and isotropic in thin section except for dispersed sub-micron, anisotropic particles that were not identifiable petrographically.

XRD Analyses

X-ray diffraction patterns obtained with a Guinier-deWolff camera on both bulk and selected samples from the two sites showed that kaolinite and montmorillonoid are the principal clay mineral constituents in the shale. Only minor quartz and plagioclase feldspar are present in the darker sample 3708-82, and negligible amounts are present in the paler sample 3707-82. Traces of mica were found in all the samples. The zeolite heulandite was identified as a rare fracture-filling constituent.

X-ray diffractograms of oriented mounts of selected specimens of the shales were also made, to confirm the identification of montmorillonoid (2,3). A strong diffraction line at 15Å that shifted to 17Å with glycolation and intensified (Fig. 4) indicated that montmorillonoid is a principal constituent. The species was not identified.

CONCLUSIONS

The rather unusual firing character of the Highvale inter-coal seam 'shale' can be explained from its mineralogical composition. The principal constituents, kaolinite and montmorillonoid, contain little iron, therefore

it fires white rather than the more common buff. Kaolinite without iron also vitrifies at higher temperatures, which would decrease its bloatability and its strength; however, the relatively high and probably variable content of montmorillonoid could strongly influence the fusion temperature. Utilization of the shale as an expandable material for lightweight aggregate may depend on determining the most favourable bloating temperature range.

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Figure 1. Shale from between coal seams in the Highvale Mine. It is dense, unstratified and fractures conchoidally amongst scattered coaly lenses. Magnification X1.

Figure 2. Sample of Fig. 1, showing the effect of wetting. The shale expands rapidly and becomes fissile, separating along irregular laminae where the rock is massive.

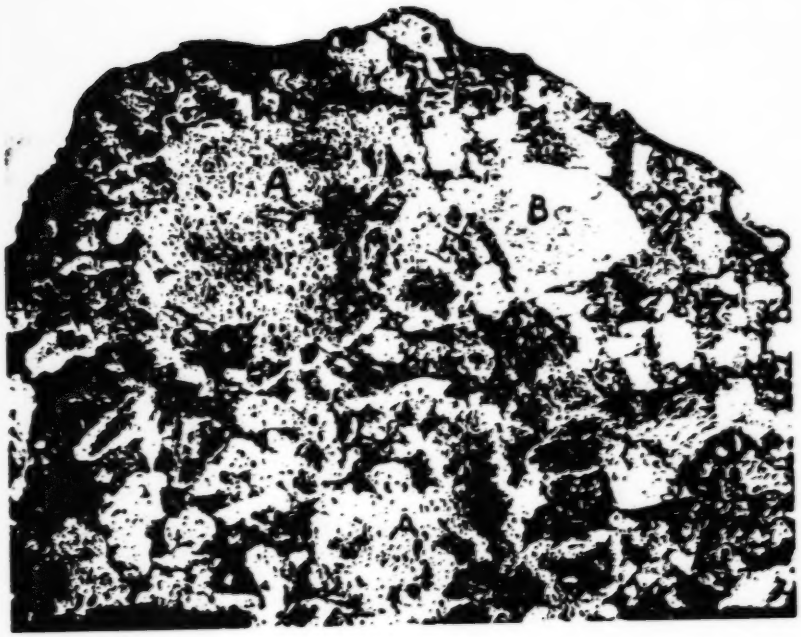

Figure 3. Impregnated, lapped section of expanded shale. Well bloated particles (A) have empty pores of low permeability and have fused well at grain boundaries. Others have bloated less well (B) and expanded along lamellae, which were easily permeated; they are poorly bonded to each other. Dark-centered areas are possibly incompletely fired.

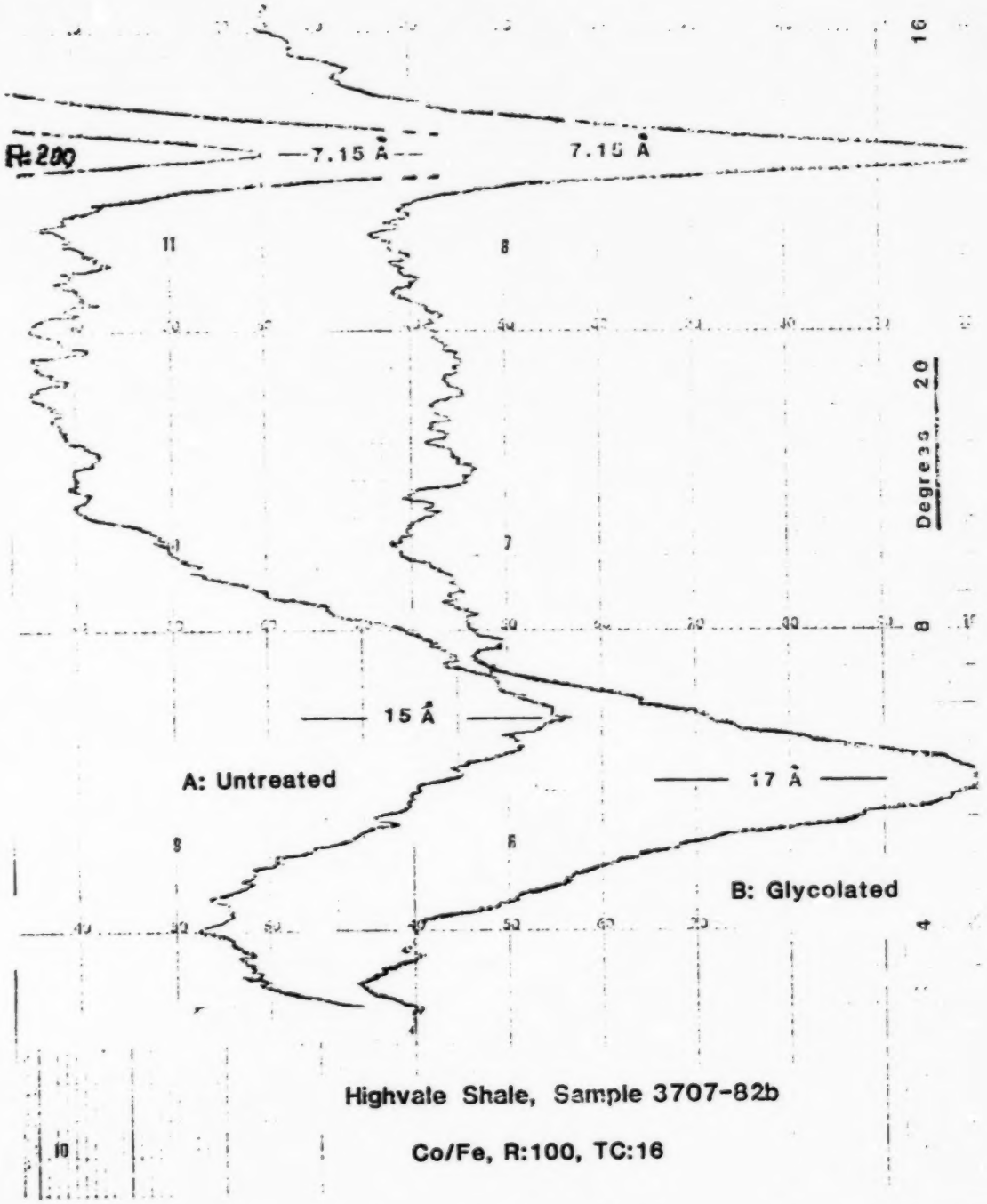

Figure 4. X-ray diffraction patterns of massive inter-coal seam shale from the Highvale mine, Alberta:
A. Sedimented mount, untreated;
B. Glycolated mount, showing shift of the broad 15Å line in (A) to an intensified 17Å spacing, typical of montmorillonoid.